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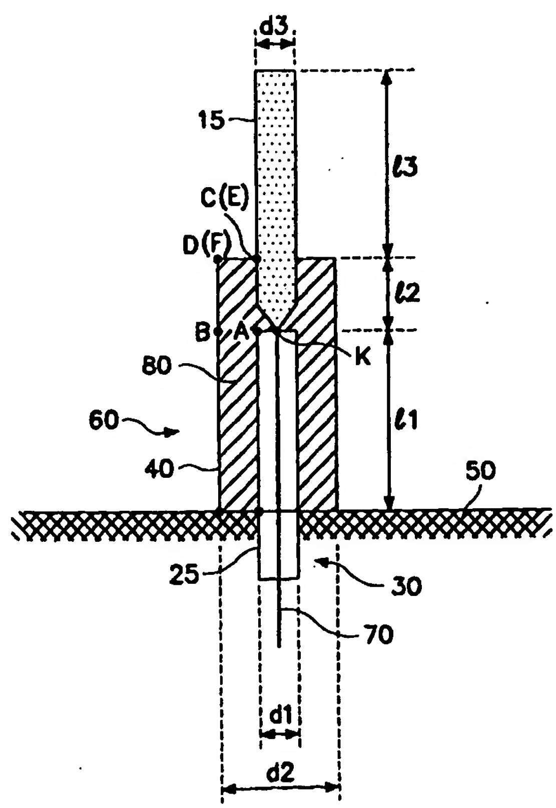
(54) Title: DUAL BAND ANTENNA

(57) Abstract

A dual band antenna for a mobile communication system which includes: a metal tube having an open end; a coaxial feed line having inner and outer conductors, with one portion of the coaxial line inserted into the metal tube, a ground plane connected to a portion of the metal tube opposite the open end and to the outer conductor of the coaxial feed line, and, a signal line electrically coupled to the inner conductor and protruding from the metal tube at the open end thereof. Preferably, the dimensions of the metal tube, the coaxial feed line and the signal line are selected such that the antenna is impedance matched to the coaxial feed line over the dual operating band, thereby obviating the need for a separate matching network.



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DUAL BAND ANTENNA

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an antenna and, more particularly, to a dual band antenna in which a separate matching circuit is not required between a signal source and the antenna, thereby having simple construction, convenient usage, low price and enhanced performance.

2. Description of the Related Art

In a mobile communication system, an antenna serves to conserve transmitting power and to use frequency efficiently. With the rapid development and widespread usage of mobile communications, there are frequent occurrences of capacity saturation in a conventional system. Thus, there is a need for a new system which works well in such environment and an interlock between a conventional system and the new system. For example, interlocks are used between: (i) a Code Division Multiple Access (CDMA) system and a Personal Communication System (PCS) in Korea; (ii) an Advanced Mobile Phone Service (AMPS) system and a PCS in the United States; (iii) a Groupe Special Mobile (GSM) system and a Digital European Cordless Telephone (DECT) system; or (IV) a GSM system and a Digital Communication System (DCS) 1800 system, applying the GSM to band 1,800MHz in Europe. Such

interlock systems are commonly called dual band systems. That is, a dual band system interlocks two different systems having frequency bands different from each other.

In conventional dual-band systems having different antennas for the respective two bands, there exists duplication in material costs which makes miniaturization and weight reduction difficult. Therefore, a dual band antenna usable at two bands has been developed.

U.S. Patent No. 4,509,056 discloses a multi-frequency antenna employing tuned sleeve chokes. FIG. 1 is a section view illustrating the construction of a monopole antenna operating at dual frequency according to an embodiment of the multi-frequency antenna employing tuned sleeve chokes. As shown in FIG. 1, an outer conductor 6 of a coaxial feed line 2 is connected to a ground plane 20 and an extension 10 of an inner conductor 8 is extended from the ground plane 20 passing through a choke 12i to a radiating section indicated as dimension N. The choke is loaded with a solid dielectric insert 16i and the inner surface of the shell of the choke and the outer surface of the conductor extending through the choke form a quarter wavelength ($\lambda/4$) transmission line. At high frequency, the choke forms a $\lambda/4$ transmission line which prevents coupling between an open end of shell 14i of the choke 12i and the extension 10. At low frequency, the choke 12i is operated not as an isolation element but as a monopole antenna indicated as the entire length P at the low resonant frequency.

The dual band antenna operating as a quarter wavelength monopole antenna at high/low band frequencies has an input impedance Z_{in} as defined in equation 1 and requires a 50Ω matching circuit in the case where it is connected to another circuit of the system. Here, the other circuit means a filter or a radio frequency (RF)

amplifier, and when it is connected to the dual band antenna, the performance of the antenna is reduced due to impedance mismatching. Therefore, the 50Ω matching circuit should be connected for preventing the mismatching as described above.

$$Z_{in} = 36 + j20 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Since the above dual band antenna requires a separate matching circuit between a signal source and the antenna, it results in complicated construction, inconvenience of usage, and high price.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a dual band antenna in which a separate matching circuit is not required between a signal source and the antenna, thereby having simple construction, convenient usage, low price and enhanced performance.

To achieve the above objects, an embodiment of the present invention is provided, that is, a dual band antenna for a mobile communication system which includes: a metal tube having an open end; a coaxial feed line having inner and outer conductors, with one portion of the coaxial line inserted into the metal tube. A ground plane is connected to a portion of the metal tube opposite the open end and to the outer conductor of the coaxial feed line. A signal line is electrically coupled to the inner conductor and protrudes from the metal tube at the open end thereof.

Preferably, the dimensions of the metal tube, the signal line, and the coaxial line are selected such that the impedance of the antenna is substantially matched to the impedance of the coaxial feed line over the dual band

of operation. Optionally, the metal tube can be filled with dielectric to shorten the antenna length.

In a more specific embodiment, a dual band antenna for a mobile communications system includes a metal tube, a coaxial feed line having one portion inserted into the metal tube, a ground plane connected to a first end of the metal tube and to the outer conductor of the coaxial feed line, and a signal line. The signal line is connected to the inner conductor of the coaxial line at a connection point within the metal tube. The outer diameter of the coaxial line is open at the connection point, thus creating a first radio frequency (RF) choke. The metal tube has a second end that is open to create a second RF choke. The signal line passes through the metal tube and protrudes past the metal tube by a predetermined length. Predetermined values are established for: the length of the coaxial line from the ground plane to the connection point; the length of the signal line from connection point to the open end of the metal tube; the length of the protruded signal line from the open end of the metal tube; the outer diameter of the outer conductor of the coaxial feed line; and diameters of the metal tube and the signal line. These values are selected such that, in an operating frequency band of said antenna, impedance of the antenna substantially matches impedance of the coaxial line, thereby providing a low standing wave ratio on the coaxial line, and obviating the need for a separate matching network.

BRIEF DESCRIPTION OF THE DRAWINGS

These and various other features and advantages of the present invention will be readily understood with reference to the following detailed description taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a section view illustrating the construction of a prior art monopole antenna operating at dual frequency having tuned sleeve chokes;

FIG. 2 is a section view illustrating the construction of a dual band antenna according to an embodiment of the present invention;

FIG. 3 is a diagram illustrating an equivalent circuit of the dual band antenna shown in FIG. 2;

FIG. 4 is a diagram illustrating an equivalent circuit of FIG. 2, once-simplified by combining signal source and impedance Z_{AB};

FIG. 5 is a diagram illustrating an equivalent circuit of FIG. 2, twice-simplified;

FIG. 6 is a diagram illustrating an equivalent circuit of FIG. 2, thrice-simplified by combining impedance Z^{**} and impedance Z_{CD} to form impedance Z_{EF} viewed from points E and F;

FIG. 7 is a diagram illustrating the equivalent circuit in which dielectric constant, d_1, d_2, l_1, l_2 and l_3 have predetermined values embodying the dual band antenna according to an embodiment of the invention;

FIG. 8 is a diagram illustrating a radiation pattern measured in comparison with a standard dipole antenna and the dual band antenna according to an embodiment of the present invention;

FIG. 9 is a diagram illustrating impedance characteristic of the dual band antenna according to an embodiment of the present invention;

FIG. 10 is a diagram illustrating standing-wave ratio (SWR) of the dual band antenna according to an embodiment of the present invention; and

FIG. 11 illustrates another embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Hereinafter, a preferred embodiment of the present invention will be described in detail with reference to the accompanying drawings. Throughout the drawings, the same reference numerals or letters will be used to designate like or equivalent elements having the same function. Furthermore, in the following description, numerous specific details such as preferred components composing the circuit are set forth to provide a more thorough understanding of the present invention. It will be apparent, however, to one skilled in the art that the present invention may be practiced without these specific details. Known function and construction unnecessarily obscuring the subject matter of the present invention will be avoided in the detailed description of the present invention.

FIG. 2 is a section view illustrating the construction of the dual band antenna according to the embodiment of the present invention, which consists of a coaxial feed line 30, a choke 60 comprising a metal tube 40 and a dielectric material 80, a signal line 15 and a ground plane 50. Herein, reference marks A to B are only used for understanding of the relation between FIG. 2 and the associated drawings showing equivalent circuits.

Preferably, one end of the metal tube 40 is connected to the ground plane 50, and the other end thereof is open. The physical length of the metal tube 40 is approximately one quarter wavelength (l_1+l_2) at the central frequency of a high frequency band. The coaxial feed line 30 is comprised of an inner conductor 70 and an outer conductor 25, wherein one portion thereof is inserted into the metal tube 40. The outer conductor 25 of the coaxial feed line 30 is connected to the ground plane 50. The above portion of the coaxial feed line 30

inserted into the metal tube is extended from the ground plane 50 toward the opened end of the metal tube 40 by the length indicated as l_1. The inner conductor 70 is connected (at point K) to a signal line 15 having the same diameter d_3 as the diameter d_1 of the outer conductor 25 of the coaxial feed line 30 at the end of the coaxial feed line 30 inserted into the metal tube 40. At point K, the outer conductor 25 of coaxial line 30 is open, thus creating an RF choke (i.e., coaxial line 30 ends at point K). The opposite end of the coaxial line is connectable to electronics (not shown), used in conjunction with the antenna, such as a transmitter and/or receiver. The signal line 15 is passed through the open end of the metal tube 40, but protrudes past the open end of the metal tube 40. The metal tube 40 has the diameter d_2 and is filled with dielectric material 80. Since the dielectric material has a dielectric constant higher than that of air, it allows the length of the metal tube 40 to be shorter for a given electrical length (as compared to an air-filled metal tube). The open end of metal tube 40 creates a second RF choke.

FIG. 3 is a diagram illustrating an equivalent circuit of the dual band antenna shown in FIG. 2. An operation of the equivalent circuit of the dual band antenna will be described hereafter.

Z_{AB} represents the impedance of the choke 60 which comprises the metal tube 40 having its width from points A to B, the coaxial feed line 30 and the dielectric material 80 filling the metal tube 40. Z_{AB} is represented by equation (2) since it is theoretically operated as a short-line.

$$Z_{AB} = Zo\tanh(\gamma l_1) \quad Z_0 = \frac{60}{\sqrt{\varepsilon_R}} \ln \frac{d_2}{d_1} ,$$

$$\gamma = \alpha + jk, \qquad K = \frac{2\pi}{\lambda} \qquad \ldots\ldots(2)$$

Excluding the attenuation constant α from equation (2) results in equation (3).

$$Z_{AB} = jZ_0 \tan(Kl_1) = j\frac{60}{\sqrt{\varepsilon_R}} \ln\frac{d_2}{d_1} \tan(Kl_1) \qquad \ldots\ldots(3)$$

wherein,

α: damping element,

K: propagation constant,

Z_0: characteristic impedance of short-line,

l_1: length from ground plane to open end of coaxial feed line,

d_1: outer diameter of outer conductor of coaxial feed line,

d_2: inner diameter of metal tube,

λ: wavelength, and

ε_R: relative dielectric constant of dielectric material.

The equivalent impedance Z_{CD} is calculated by the above equations 2 and 3, and if the diameter d_1 of the outer conductor 25 of the coaxial feed line 30 is equal to the diameter d_3 of the signal line 15, the impedance Z_{CD} can be calculated by changing length (l_1+l_2). The impedance Z_{CD} is indicated by equation (4).

$$Z_{CD} = j\frac{60}{\sqrt{\varepsilon_R}} \ln\frac{d_2}{d_1} \tan\left[\frac{2\pi}{\lambda}(l_1+l_2)\right] \qquad \ldots\ldots(4)$$

FIG. 4 is a diagram illustrating an equivalent circuit once-simplified by combining signal source and impedance Z_{AB}. Impedance Z^* is represented by equation (5).

$$Z^{*}= \frac{50 \cdot Z_{AB}}{Z_{AB}+50} \qquad \ldots\ldots(5)$$

FIG. 5 is a diagram illustrating an equivalent circuit twice-simplified with the simplified equivalent circuit shown in FIG. 4. Referring to FIG. 2, since the length l_2 from the upper end of coaxial feed line 30 to the open end of the metal tube 40 is constructed and operated as one portion of the signal line 15 and the metal tube 40, if it is combined with the impedance Z^{*}, the equivalent circuit as shown in FIG. 4 can be obtained. An impedance Z^{**} according to the equivalent circuit of the FIG.4 can be obtained as indicated by equation (6).

$$Z^{**}=Z_0 \frac{[\frac{Z^{*}}{Z_0}+\tanh(\gamma l_2)]}{[1+\frac{Z^{*}}{Z_0}j\tanh(\gamma l_2)]} = \frac{[\frac{Z^{*}}{Z_0}+j\tan(\frac{2\pi}{\lambda}l_2)]}{[1+\frac{Z^{*}}{Z_0}j\tan(\frac{2\pi}{\lambda}l_2)]} \qquad \ldots\ldots(6)$$

FIG. 6 is a diagram illustrating an impedance Z_{EF} viewed from points E and F in an equivalent circuit in which impedance Z^{**} and impedance Z_{CD} are combined. Then, impedance Z_{EF} can be obtained as indicated by equation (7).

$$Z_{EF}= \frac{Z^{**}Z_{CD}}{Z^{**}+Z_{CD}} \qquad \ldots\ldots(7)$$

Accordingly, impedance Z_{EF} is calculated by changing variables such as frequency, dielectric constant, d_1, d_2, l_1, l_2 and l_3.

FIG. 7 is a diagram illustrating the equivalent circuit in which dielectric constant, d_1, d_2, l_1, l_2 and l_3 have predetermined values embodying a dual band antenna according to an embodiment of the present invention. Since signal source impedance Z_{EF} varies with operating frequency, it will be designated as $Z_{EF}(f)$. $Z_{EF}(f)$ is shown in FIG. 6 having the antenna as a load. Since antenna

impedance Z_{ANT} also varies with frequency, it will be designated as $Z_{ANT}(f)$. Accordingly, signal source impedance $Z_{EF}(f)$, having an integral variable matching circuit, thus equals antenna impedance $Z_{ANT}(f)$. Therefore, in the embodiment of the present invention, variables dielectric rate, d_1, d_2, l_1, l_2 and l_3 are varied upon construction of impedance $Z_{EF}(f)$, so that impedance $Z_{HF}(f)$ and impedance $Z_{ANT}(f)$ can be embodied to be equal to each other. Thus, a matching condition between the signal source and the antenna can be exactly achieved and can improve the characteristics of the dual band antenna.

FIG. 8 is a diagram illustrating a radiation pattern measured in comparison with a standard dipole antenna and the dual band antenna according to an embodiment of the present invention. FIG. 9 is a diagram illustrating impedance characteristic of the dual band antenna according to an embodiment of the present invention, and FIG. 10 is a diagram illustrating a standing-wave ratio (SWR) of the dual band antenna according to an embodiment of the present invention. At this moment, the CDMA and Korean PCS frequency of the dual band antenna will be given as follows: the CDMA frequency is 824 ~ 849MH_Z upon transmission and 869 ~ 894 MH_Z upon reception; the Korean PCS frequency is 1750 ~ 1780MH_Z upon transmission and 1840 ~ 1870MH_Z upon reception. Because the dual band antenna may be applied to systems of the GSM/DECT, GSM/DCS 1800, the AMPS and CDMA/PCS, it can be easily made by varying first length l_1 and second length l_2 of the choke 60 divided at the point (point K) in which the inner conductor 70 of the coaxial feed line 30 and the signal line 15 are connected with each other as shown in FIG. 2. If the length l_1+l_2 of the choke 60 is varied, the resonant point of the high frequency band is moved, however, as indicated in FIG. 10 by the dotted line 81,

the resonant point of the low frequency band is barely moved as shown in FIG. 10. Referring to the solid line as thickly indicated in FIG. 9, an interval Δ from a start point to point 3, covering points 1 and 2, shows the characteristic of the low frequency band (824 ~ $894MH_Z$). An interval that returns to the start point by covering points 3 and 4 indicated as Δ shows the characteristic of the high frequency band (1,750 ~ $1,870MH_Z$). The intervals between points 1 and 2, between 3 and 4, are the same as those as shown in FIG. 10.

FIG. 11 shows an alternate embodiment of the present invention. This embodiment is similar to the embodiment described in connection with FIG. 2, except that the signal line 15 is replaced by a signal line 15'. Signal line 15' consists of a first linear portion 15a of length l_2 and a spiral portion 15b of length l_3. The diameter of both portions 15a and 15b is d3, although the diameter of the spiral portion 15a may be selected different than the linear portion 15b.

The embodiments of the present invention described above have advantages in that a variable matching circuit is provided, thus a separate matching circuit is not required between a signal source and an antenna, thereby having a simple construction, convenient usage, low price and enhanced performance.

While what has been illustrated and described is considered to be the preferred embodiments of the present invention, it will be understood by those skilled in that art that various changes and modifications may be made, and equivalents may be substituted for elements thereof, without departing from the true scope of the present invention.

WHAT IS CLAIMED IS:

1. A dual band antenna for a mobile communication system, comprising:

a metal tube having an open end;

a coaxial feed line having inner and outer conductors, said coaxial feed line having one portion inserted into said metal tube;

a ground plane connected to a portion of said metal tube opposite said open end and to said outer conductor of said coaxial feed line; and

a signal line electrically coupled to said inner conductor and protruding from said metal tube at the open end thereof.

2. The dual band antenna for a mobile communication system as claimed in claim 1, wherein length of said metal tube is longer than a length of said inserted coaxial feed line from said ground plane.

3. The dual band antenna for a mobile communication system as claimed in claim 1, wherein a portion of said metal tube is filled with a dielectric material for reducing the length of said metal tube.

4. The dual band antenna for a mobile communication system as claimed in claim 1, wherein outer diameters of said coaxial feed line and said signal line are equal to each other.

5. The dual band antenna for a mobile communication system as claimed in claim 1, wherein said portion of said signal line protruded from said metal tube is shaped in a format of a straight line.

6. The dual band antenna for a mobile communication system as claimed in claim 1, wherein said portion of said signal line protruded from said metal tube is shaped in a format of a spiral line.

7. The dual band antenna for a mobile communication system as claimed in claim 1, wherein the physical length of said metal tube has approximately one-quarter wavelength at a central frequency of a high frequency band.

8. The dual band antenna for a mobile communication system as claimed in claim 2, wherein said metal tube is filled with a dielectric material for reducing the length of said metal tube.

9. The dual band antenna for a mobile communication system as claimed in claim 2, wherein outer diameters of said coaxial feed line and said signal line are equal to each other.

10. The dual band antenna of claim 1, wherein dimensions of said metal tube, dimensions of said signal line and of said coaxial line and dielectric constant of dielectric within said metal tube are selected such that impedance of said antenna is substantially matched to impedance of said coaxial feed line over said dual band.

11. The antenna of claim 10, wherein said dual band comprises a lower frequency band and a higher frequency band substantially twice said low frequency band.

12. The antenna of claim 11, wherein said lower frequency band is from about 824-894 MHz and said higher

frequency band is from about 1750-1870 MHz.

13. A dual band antenna for a mobile communication system, comprising:

a metal tube;

a coaxial feed line composed of an inner conductor and an outer conductor, said coaxial feed line having one portion inserted into said metal tube;

a ground plane connected to one end of said metal tube and to said outer conductor;

a signal line connected to said inner conductor within said metal tube at a connection point within said metal tube, said outer diameter of said coaxial line being open at said connection point, thereby creating a first radio frequency (RF) choke;

said metal tube having another end that is open to create a second RF choke;

said signal line passing through said metal tube and protruding past said metal tube by a predetermined length;

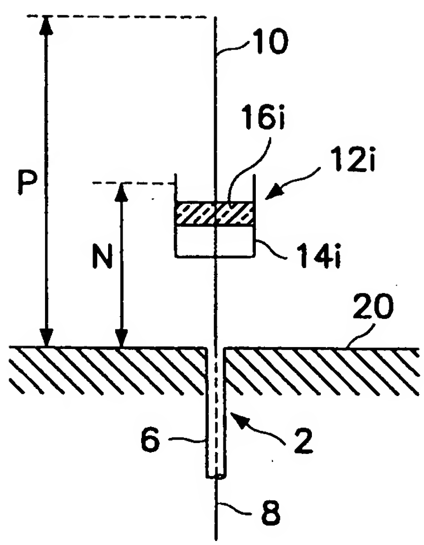
wherein length of said coaxial line from said ground plane to said connection point, length of said signal line from said connection point to said open end of said metal tube, length of said protruded signal line from said open end of said metal tube, outer diameter of said outer conductor of said coaxial feed line, and diameters of said metal tube and said signal line having respective predetermined values, whereby in an operating frequency band of said antenna, impedance of said antenna substantially matches impedance of said coaxial line, thereby providing a low standing wave ratio on said coaxial line.

14. The antenna of claim 13, wherein at least a

portion of said metal tube is filled with dielectric and dielectric constant of said dielectric being selected to provide said low standing wave ratio on said coaxial line.

15. The antenna of claim 13, wherein said operating band comprises a dual band including a lower band and a higher band substantially twice said lower band.

16. The antenna of claim 13, wherein said lower band is from about 824-894 MHz and said higher band is from about 1750-1870 MHz.



(PRIOR ART)
FIG. 1

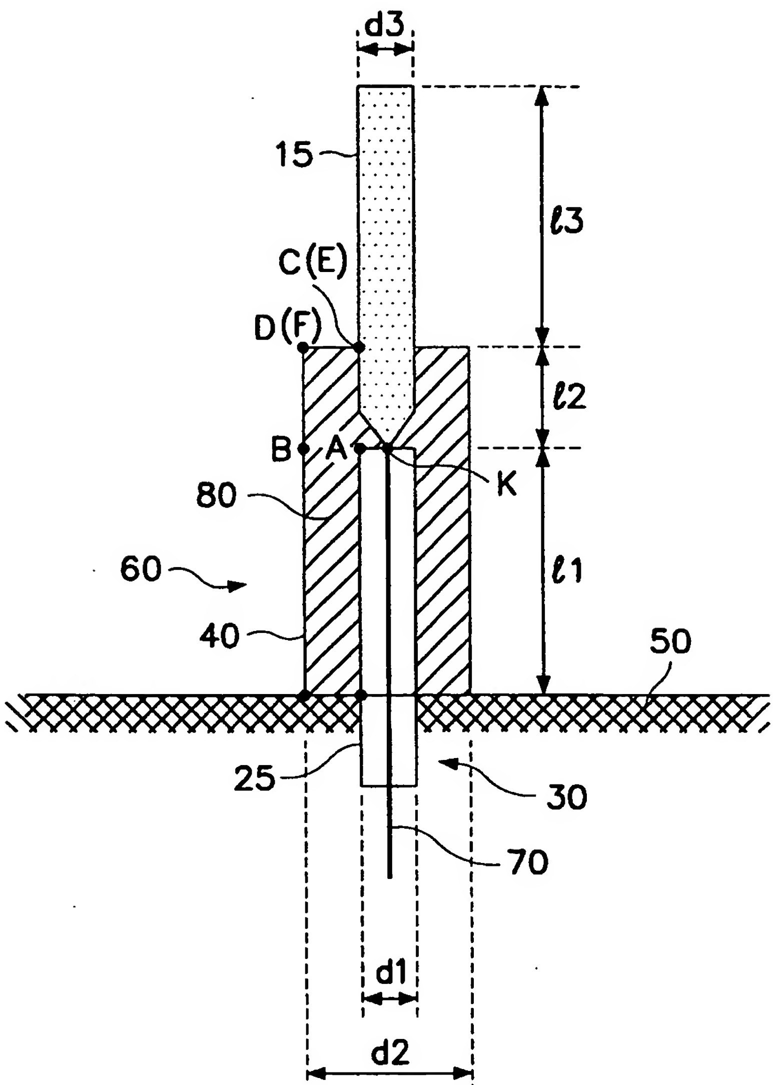


FIG. 2

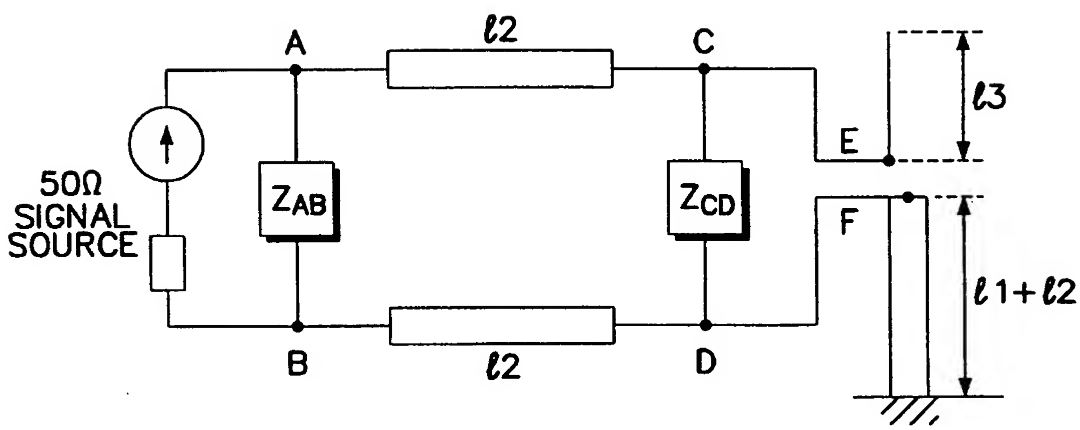


FIG. 3

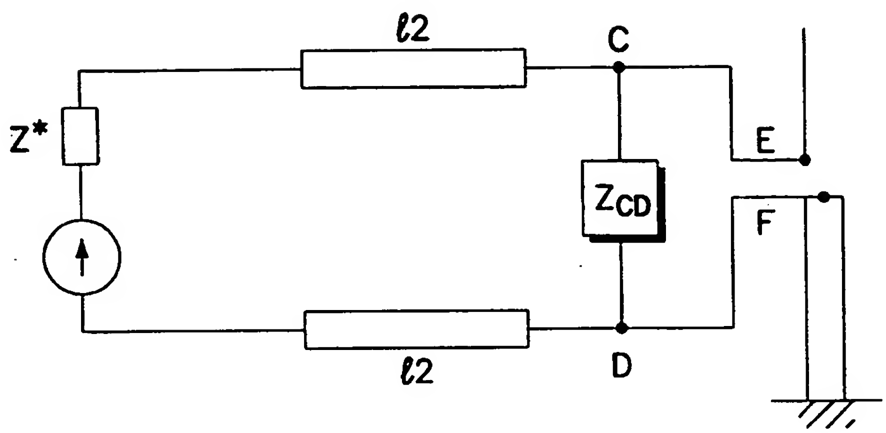


FIG. 4

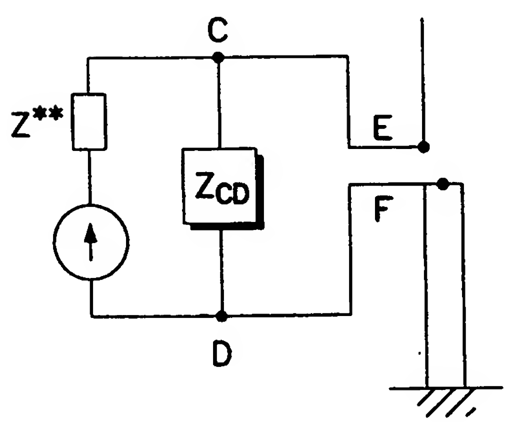


FIG. 5

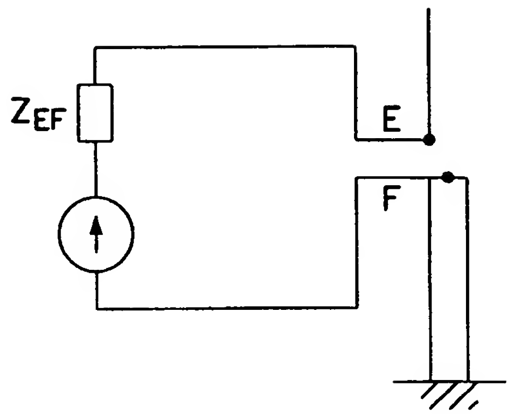


FIG. 6

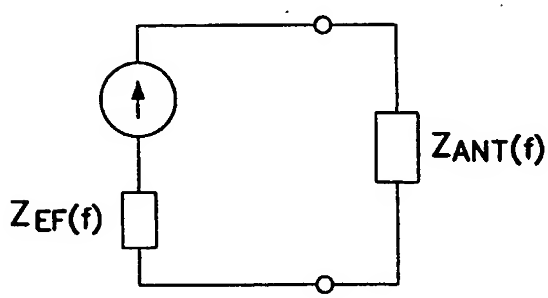
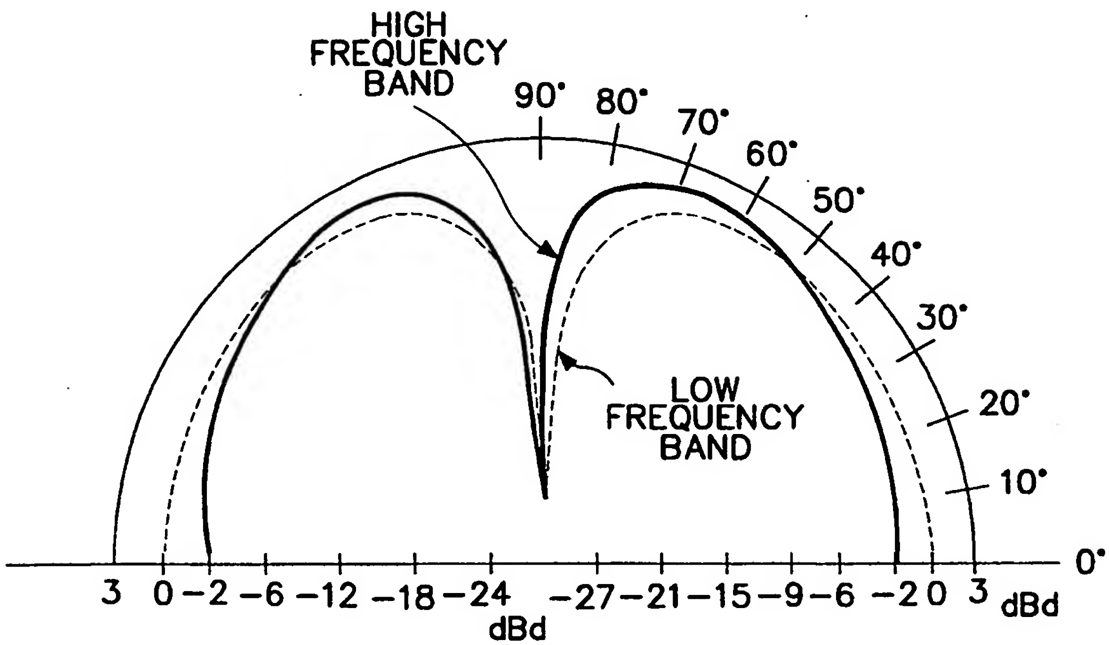


FIG. 7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FREQUENCY
BAND
90°
80°
70°
60°
50°
40°
30°
20°
10°
0°
LOW
FREQUENCY
BAND
3 0 −2 −6 −12 −18 −24
dBd
−27 −21 −15 −9 −6 −2 0 3
dBd

FIG. 8

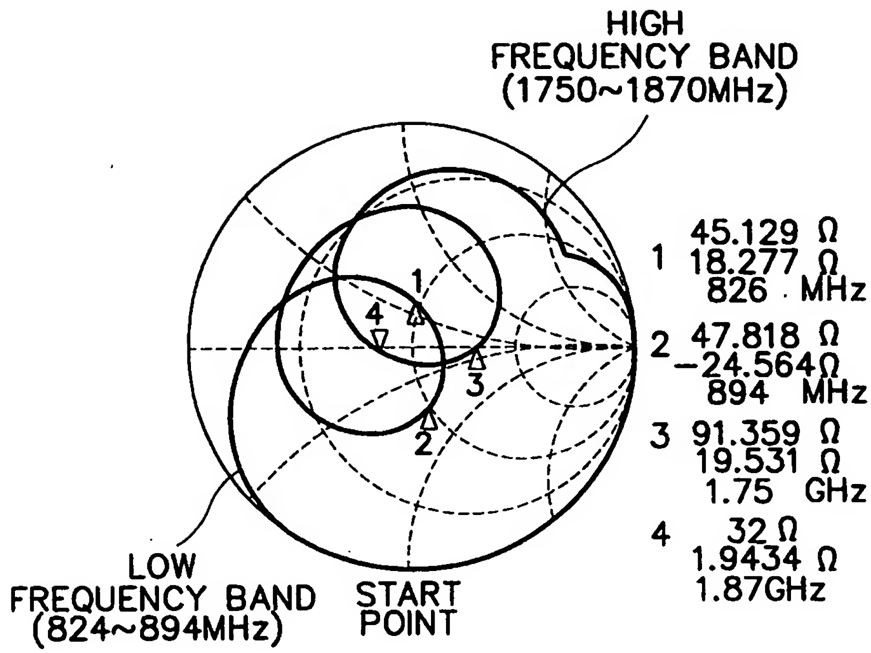
HIGH
FREQUENCY BAND
(1750~1870MHz)
1 45.129 Ω
18.277 Ω
826 MHz
2 47.818 Ω
-24.564Ω
894 MHz
3 91.359 Ω
19.531 Ω
1.75 GHz
4 32 Ω
1.9434 Ω
1.87GHz
LOW
FREQUENCY BAND
(824~894MHz)
START
POINT

FIG. 9

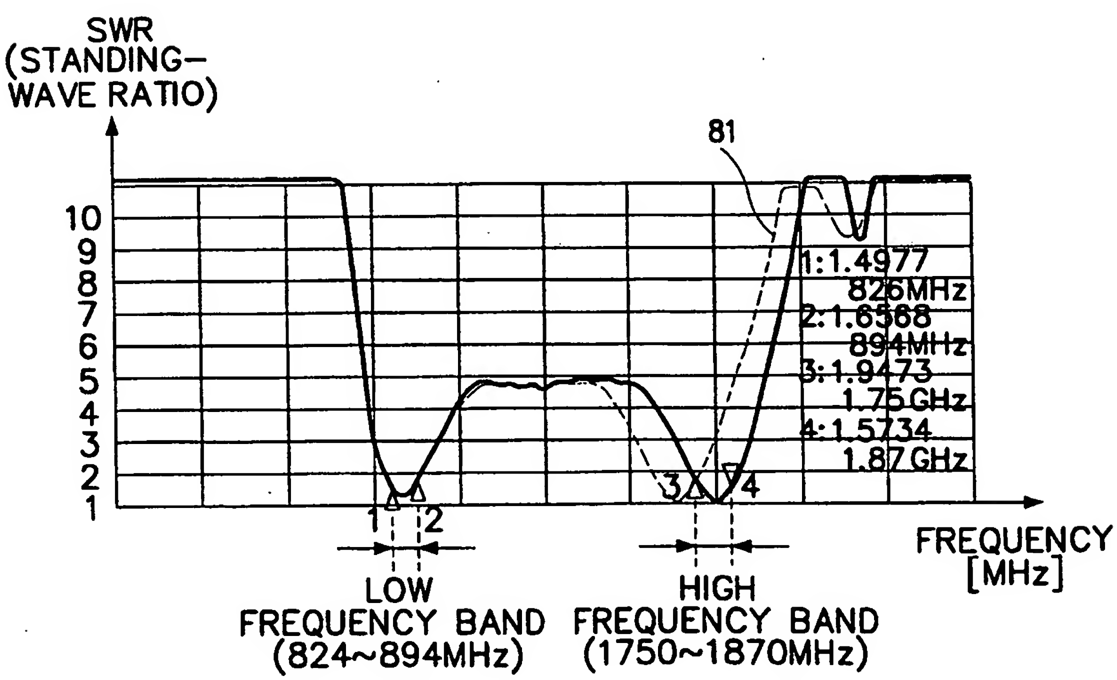
SWR
(STANDING-
WAVE RATIO)
81
10
9
8
7
6
5
4
3
2
1
1:1.4977
826MHz
2:1.6568
894MHz
3:1.9473
1.75GHz
4:1.5734
1.87GHz
FREQUENCY
[MHz]
LOW
FREQUENCY BAND
(824~894MHz)
HIGH
FREQUENCY BAND
(1750~1870MHz)

FIG. 10

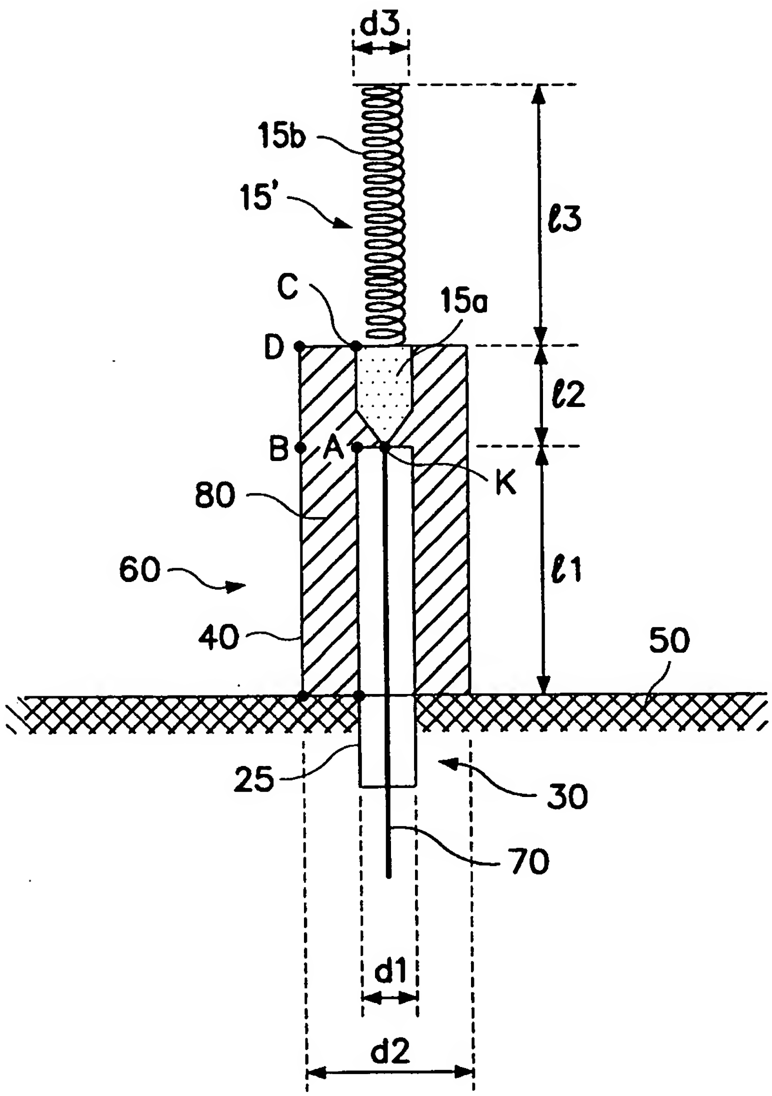

FIG. 11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR 97/00146

A. CLASSIFICATION OF SUBJECT MATTER

IPC[6]: H 01 Q 1/24, 9/18, 13/08; H 04 B 1/18, 1/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC[6]: H 01 Q; H 04 B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPIL, EPODOC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 730 195 A (PHILLIPS et al.) 08 March 1988 (08.03.88), totality.	1-16
A	US 3 932 873 A (GARCIA) 13 January 1976 (13.01.76), totality.	1-16
A	Patent Abstracts of Japan, Vol. 18, No.120, (E-1516), 1994, JP 5-315827 (HARADA).	1-16
A	Patent Abstracts of Japan, Vol. 14, No.537, (E-1006), 1990, JP 2-228102 (NIPPONDENSO CO. LTD.).	1-16
A	Patent Abstracts of Japan, Vol. 10, No.113, (E-339), 1986, JP 60-249403 (NIPPON DENSHIN DENWA KOSHA).	1-16

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
08 November 1997 (08.11.97)	20 November 1997 (20.11.97)

Name and mailing address of the ISA/ AT	Authorized officer
AUSTRIAN PATENT OFFICE Kohlmarkt 8-10 A-1014 Vienna Facsimile No. 1/53424/535	Heinich Telephone No. 1/53424/454

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR 97/00146

Im Recherchenbericht angeführtes Patentdokument Patent document cited in search report Document de brevet cité dans le rapport de recherche	Datum der Veröffentlichung Publication date Date de publication	Mitglied(er) der Patentfamilie Patent family member(s) Membre(s) de la famille de brevets	Datum der Veröffentlichung Publication date Date de publication
US A 4730195	08-03-88	keine - none - rien	
US A 3932873	13-01-76	keine - none - rien	

Form PCT/ISA/210 (patent family annex) (July 1992)